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GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION AND POWER
CENTRAL WATER & POWER COMMISSION
(POWER WING)

CODE OF PRACTICE
AS REGARDS
WIND PRESSURES AND TEMPERATURE VARIATIONS FOR THE DESIGN OF OVERHEAD POWER LINES

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FOREWORD

One of the functions of this Commission is to standardize instruments, methods of observations and record, materials and construction, design and operational features, and to review and lay down for the whole of India standard practices for generation, transmission and distribution of electrical energy.

Accordingly, this Commission undertook the study of the practices followed in this country as regards the maximum wind pressures and the temperature variations adopted for the design of overhead power lines and issued a circular in April, 1950, formulating certain proposals on the subject and inviting comments from all the interests concerned. The conclusions of this study are embodied in this Code.

The Code of Practice as now issued is *recommendatory and not mandatory.* It is, however, hoped that the State Government Electricity Departments, Public Electricity Supply Undertakings, etc., will follow these recommendations in all their future line designs. Based on the experience gained in the next few years, this Code will be suitably revised, if necessary so as to ensure all possible economies and simplification of line designs.

New Delhi,
July, 1952.

S. A. GADKARY.

1481CWPC(PW)

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INTRODUCTION

The growth of transmission systems in India and the programme for the development of several Hydro-electric schemes all over the country have brought to the fore the question of standardizing the wind pressures and temperature variations to be adopted in the design of overhead power lines in this country, in order to ensure a fair compromise between the actual weather conditions obtaining in different areas and the overall need to evolve certain uniform standards and simplifications in the line design and construction practices.

2. The present practice in this regard is governed by Rules 68(2) and (3) of the Indian Electricity Rules, 1937, which are reproduced below :

68(2). "For the purpose of calculating the factors of safety :—

(a) the maximum wind pressure shall be specified by the provincial Government in each case ;

(b) for cylindrical bodies the effective area shall be taken as two-thirds of the sectional area exposed to wind pressure ;

(c) for lattice steel or other compound structures the wind pressure on the lee-side members shall be taken as one-half of the wind pressure on the windward side members, and the factor of safety shall be calculated on the crippling load of struts and upon the elastic limit of tension members ;

(d) the temperature shall be taken as 32°F or such other temperature as the provincial Government may specify.

68(3). Notwithstanding anything in sub-rules (1) and (2), in localities where aerial lines are liable to accumulations of ice or snow, the provincial Government may, by order in writing, specify such factor of safety as it may think fit and the conditions under which it is to be calculated."

3. In accordance with these Rules, the maximum wind pressures and temperature variations have been specified by the State Governments in each case. In practice, this has resulted in a wide variety of design data which are not fully coordinated with the actual weather conditions that do not necessarily change at the State boundaries. Furthermore, this has proved to be a major handicap to the evolution of standardized and economical designs and exchange of useful information among the various states. It is therefore considered important to lay down rational standards for the country as a whole, and regardless of administrative dividing lines.

4. In April 1950, this Commission formulated certain proposals on the subject and invited comments from all State Government Electricity Departments, major Public Electricity Supply Undertakings, Railways, etc. The comments received represent a fair cross-section of informed opinion, and brief summaries of these comments together with this Commission's remarks are given in Annexure V.

5. The Indian Meteorological Department were consulted by this Commission at every stage, and their assistance and cooperation have been of great value in the preparation of this Code.

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CODE OF PRACTICE AS REGARDS WIND PRESSURES AND TEMPERATURE VARIATIONS FOR THE DESIGN OF OVERHEAD POWER LINES

1. SCOPE

This Code stipulates the maximum wind pressures and the temperature variations to be adopted for the design of overhead power lines in this country, excluding the areas at altitudes greater than 3,000 ft.

2. WIND PRESSURES

2.1. **Wind Pressure Map of India.**—The Map of India in Exhibit I shows the wind pressures recommended for adoption in different parts of the country for the design of overhead lines.

2.2. **Classification of Loadings.**—The wind pressure map in Exhibit I gives the three broad loading regions designated as (i) 15 lb. per sq. ft. region, (ii) 20 lb. per sq. ft. region, and (iii) 30 lb. per sq. ft. region.

2.3. **Exceptions to the Classification—**

1. Rural lines up to and including 11 kV in the 15 lb. region shown in blue colour in Exhibit I may be designed on the basis of 10 lb. per sq. ft.

2. Lines situated within 10 miles of the coast in the region shown in red colour in Exhibit I may be designed on the basis of 30 lb. per sq. ft.

2.4. **Effect of Altitude on Wind Pressures.**—The wind pressure chart gives an idea of the maximum pressure due to wind likely to be experienced over different parts of the country within a height of about 100 feet above the ground level, and this is irrespective of the height of the place above sea level (see Annexure III). The altitude of the country traversed by the overhead line may therefore be ignored in so far as the maximum wind pressure on supports and wires is concerned.

2.5. **Wind Pressure on Wires.**—The factor to be used for assessing the wind pressure on wires may be taken as two-thirds the sectional area exposed to wind pressure for both solid and stranded wires.

2.6. **Wind Pressure on Supporting Structures—**

1. The same wind pressure assumed for the wires (as per Exhibit I) may be used for the supports as well.

2. In the case of lattice steel and other compound structures (including A & H poles), the wind pressure on the lee-side members may be taken as one-half the wind pressure on the wind-ward side members.

3. TEMPERATURE VARIATIONS

The Map of India dividing the country into three ranges corresponding to temperature variations of 80°, 100° and 120°F is given in Exhibit II.

4. ANNEXURES

Annexures I to IV are copies of important letters from the Indian Meteorological Department elucidating the various points raised by this Commission before formulating this Code. Annexure V is a brief summary of the views and suggestions received from the various State Government Electricity Departments and other organizations on the standardization proposals, and this Commission's comments thereon.

ANNEXURE I

Copy of letter No. SS80715 dated the 31st July, 1950, from the Deputy Director General of Observatories, (Climatology and Geophysics), Poona, to the Central Electricity Commission, Simla.

SUBJECT :—*Standardisation of Wind Pressure and Temperature variations as regards the design of overhead lines.*

With reference to your letter No. CEC.10/34/13-V-10114 dated the 9th June, 1950, forwarding a copy of letter No. EE4/CEC/2677 dated the 5th June, 1950, from the Office of the Electrical Engineer to Government of Saurashtra, Rajkot, it may be stated that although we have no systematic data of very high velocities for a long period, a wind pressure of 40 lb./sq. ft. (which corresponds to a velocity of 115 mph) is the probable highest maximum to be expected. Such a high wind pressure may occur only under very exceptional circumstances and on very rare occasions in Saurashtra area.

Wind velocities of the order of 100 mph (corresponding to a pressure of 30 lb./sq. ft.) have been recorded on North Bombay Coast and also near Karachi. In the cyclonic storm of November, 1948, Bombay recorded 94 mph but places to the north of it along the coast probably recorded higher velocities. As Kathiawar Coast is also struck by severe cyclonic storms and severe squalls, though on rare occasions, such very high velocities are not improbable. While therefore providing for a pressure of 25 lb./sq. ft. in the coastal area of Saurashtra and 20 lb./sq. ft. in the inland area may be generally sufficient, there may be rare occasions when a wind pressure of 30 to 40 lb. may be felt along the coast and 25 lb. to 30 lb. in the interior, but the duration during which such very high velocities may be experienced may be a few minutes in the case of severe squalls and a few minutes to a few hours in the case of severe cyclonic storms.

ANNEXURE II

Copy of letter No. SS80715 dated the 25th August, 1950, from the Deputy Director General of Observatories, (Climatology and Geophysics), Poona, to the Central Electricity Commission, Simla.

With reference to your letter No. CEC.10/34/13-10467 dated the 12th July, 1950, I am to state that a similar enquiry from you regarding the shading of the Bombay and Kathiawar coasts up to 40 lb./sq. ft. has been replied to vide this Office letter No. SS 80715 dated 31st July, 1950.

The following remarks are offered regarding the shading of Bengal, Orissa and North Madras coasts, equivalent to a maximum wind pressure 40 lb./sq. ft. Strong winds along this coast are associated with severe storms which sometimes cross these coasts. It may, therefore, be stated that on an average one severe storm may be expected to cross any of these coasts in two years. Of the most severe storms which gave rise to very high wind velocities, mention is made of the Midnapore cyclone of October, 1942. One of the Pilot vessels 'Lady Fraser' which was anchored in the Beaumont Channel (Lat. 21°33′ N and Long. 87°57′ E) at the time recorded a velocity of 120 m.p.h. before the anemometor was blown off. Later, the wind velocity is estimated to have reached about 140 m.p.h. for a short period.

A feature of these storms is that they usually weaken rapidly after crossing the coast and the interior of the country does not experience such strong winds. The number of such very severe storms on record as the one mentioned above is very small and in the absence of systematic data, it is not possible to indicate definitely the probability and frequency of occurrence of the maximum wind pressure equivalent to 40 lb./sq. ft. over the different places in the shaded area. It may, however, be stated that while generally the provision for wind velocities of 100 m.p.h. (corresponding to 30 lb./sq. ft.) along the North Madras, Orissa and Bengal coasts above 16°N may be sufficient, there have been occasions in the past when winds over 100 m.p.h. have actually been recorded in this area.

ANNEXURE III

Copy of letter No. SS80715 dated the 3rd May, 1952, from the Deputy Director General of Observatories (Climatology and Geophysics), Poona, to the Central Water and Power Commission (Power Wing), Simla.

SUBJECT :—*Wind Pressure over India.*

With reference to the correspondence resting with your letter dated the 26th February 1952, on the above subject, I would state that the chart supplied to you does not correspond to wind pressures at sea-level but only gives an idea of the probable maximum pressure due to wind likely to be experienced over different parts of the country. The chart is based on wind observations recorded at the various observatories (with the instruments exposed at varying heights generally not exceeding 100 ft. from the ground) irrespective of the elevation of the station above the mean sea level. Therefore, the question of applying a correction factor for the variation of height of the station above mean sea level does not arise while making use of the chart.

It may be mentioned that on an average, the wind velocity at a given place, increases with height, the extent of increase depending upon the height, the season of the year, the time of the day, etc. This, however, is not applicable in the case of extreme velocities which are involved in the calculation of the maximum wind pressures used for the chart, since there is no general rule known regarding the variation of maximum wind with height.

ANNEXURE IV

Copy of letter No. SS80715 dated 8th July, 1950, from the Deputy Director General of Observatories, (Climatology and Geophysics), Poona, to the Central Electricity Commission, Simla.

With reference to your letter No. CEC.10/34/13-V-9992 dated the 30th May, 1950, I write to inform you that data regarding the simultaneous occurrence of maximum wind pressures and minimum temperatures in various parts of India are not available. It may, however, be mentioned that the lowest minimum temperatures, data of which were supplied to you, occur during the winter season when, in general, weather is not disturbed and gales and storms are rare. It, therefore, appears that the probability of occurrence of maximum wind pressures, associated with gales and stormy winds which prevail for appreciable periods of hours at a time, simultaneously with the time of occurrence of the lowest minimum temperatures, is small.

ANNEXURE V

Brief Summary of comments on CWPC's proposals for standardization of wind pressures and temperature variations as regards the design of overhead lines.

	CWPC'S Remarks.
1. *East Punjab State Government P.W.D. Electricity Branch.*	
(i) They are in favour of standardization.	
(ii) They agree that the wind pressure on the structures and the conductors should be the same.	
(iii) Their present designs are based on a wind pressure of 12 lb./sq. ft. for 66 kV lines and above and 11 lb./sq. ft. for lines below 66 kV, and the maximum and minimum temperatures of 140°F and 32°F respectively, and they feel that the adoption of 15 lb./sq. ft. as recommended by the Commission would increase the cost of structures.	While it is admitted that there will be a certain amount of increase in the weight of structures due to adoption of 15 lb. in place of 11 or 12 lb., any proposal for standardization of this nature covering vast areas is bound to result in small differences in respect of sags of conductors and weights of structures. Standard Codes must satisfy rather wide needs, the primary object being the evolution of uniform standards and simplifications in the design and construction practices, which would ultimately result in substantial overall economies for the country as a whole.
(iv) They question the basis for assuming different wind pressures as between rural lines up to 11 kV and other transmission and distribution lines in the region shown in blue colour in Exhibit I.	The relaxation in favour of rural lines will involve a saving of 5 to 15 per cent. in line costs, and any step taken in the direction of reducing the costs of rural electrification, without at the same time jeopardizing the safety and dependability of the line designs will go a long way in spreading the use of electricity in rural areas. A somewhat greater margin of safety is however warranted for lines of greater importance which may serve urban areas and industrial loads of importance.
(v) They are of opinion that the proposal to upgrade and merge the region shown in blue colour in Exhibit I (normally classed as 10 lb. as per the IMD Map) with the 15 lb. region shown in green colour except for rural lines up to 11 kV, would not achieve the desired economies in the cost of lines and the figure of 10 lb. may be increased by one or two lb. but not by 5 lb.	It is felt that this modification would serve as a compromise between the existing practices on the one hand and the the zonal demarcation by the Indian Meteorological Department on the other, and at the same time ensure a measure of economy in respect of rural electrification schemes.

(vi) Their usual practice is to assume an increase in wind pressure of 1 lb. per sq. ft. for every 1000 ft. increase in altitude of a place above sea level and they are accordingly adopting, for examples, 18 lb. pressure for Simla.

It has been ascertained from the IMD (see Annexure III) that the wind pressure chart does not correspond to wind pressures at sea level but only gives an idea of the maximum pressure likely to be experienced over various parts of the country up to a height of about 100 feet above the ground level whatever may be the elevation of the station above the mean sea level. The question of applying a correction factor for the variation of height of the station above mean sea level does not therefore arise.

2. *The Hydro-Electrical Engineer, Uttar Pradesh Government P.W.D.*

(i) In addition to the maximum wind pressures in the normal conditions as the Wind Pressure Map gives, data should be made available for the abnormal conditions taking into consideration the thunder-squalls, 'Norwesters' of Bengal and the dust and thunder storms of Northern India. The designs of structures should be checked under worst storm conditions also.

From the point of view of reliability as well as economy, it is considered sufficient to base the designs on the values indicated in the Wind Pressure Map. Data as regards the more abnormal conditions such as tornedoes, thunder-squalls, etc., are not available with a fair approach to accuracy, and in view of so many uncertain conditions involved, it is also not considered necessary to make a double check of the factors of safety as suggested.

(ii) They agree that the same wind pressure may be assumed for towers as for conductors but suggest that the designs of structures should be rechecked under conditions more severe than the design loadings.

Designs based on a particular value of maximum wind pressure with a certain factor of safety should quite suffice, and the factors of safety would ordinarily take care of such improbabilities.

(iii) They agree that the 2/3 factor can be uniformly applied for all solid and stranded wires in assessing the wind load on conductors.

(iv) They suggest that as the maximum temperature for the purpose of line designs in Uttar Pradesh should be 150°F instead of 140°F as per the temperature variation chart in Exhibit II, the chart should be modified accordingly.

Variations of the this order are bound to occur when the whole country is divided into three regions with definite values assigned to each area. This sub-division, while necessarily a matter of compromise and judgment, is considered adequate and satisfactory from the point of view of economy or reliability, in addition to ensuring simplicity and uniformity of designs.

When considering temperature variation in relation to maximum sag of conductor and the resultant height of the supporting structures, the maximum sag of conductor occurs at maximum temperature and in still air, as no ice loading occurs in most parts of India (excluding the lines situated in the Himalayan range). Even if the actual temperature of the conductors increases beyond the limits as specified in Exhibit II, and consequently the minimum ground clearance is reduced a little, say, from 20 feet to 19 feet for a short time

under combination of adverse conditions (i.e., maximum ambient temperature, still air and heating effect of current), no serious situation is likely to arise therefrom. Although the maximum calculated sags are based on the maximum temperature in still air conditions, wind velocities of less than 2 miles per hour occur less than 5 per cent of the time, except in very rare cases of sheltered locations. A gentle wind of 2 miles per hour takes away the heat from the conductor to a very appreciable extent. Further, the vertical component of the sag is also slightly reduced due to wind. It may be mentioned in this connection that the practice in the U.S.A. for determining the vertical clearances of wires above ground (vide Handbook No. H-32 issued by the National Bureau of Standards) is mainly based on the condition of 60°F temperature and still air for voltages up to 50,000 volts between conductors and maximum span lengths ranging from 175 feet to 350 feet, depending on the loading district; for higher voltages and greater span lengths, additional clearances are provided to allow for various other factors including higher operating temperatures.

Somewhat similar considerations apply in the case of minimum temperature limits as well. The condition of minimum temperature and maximum wind determines the maximum tension of the conductors (in other words, the factor of safety of the conductors under the worst conditions) and the resultant loadings on the supporting structures. It has been ascertained from the IMD that the simultaneous occurrence of minimum temperature and maximum wind is very improbable, as storm weather conditions do not occur in the winter months (see Annexure IV). If therefore the actual minimum temperatures are somewhat less than those specified in Exhibit II, this will not be of any major consequence.

In view of the several uncertain variables discussed above, a difference of 10° or 20°F would be immaterial and the temperature limits as given in Exhibit II may be considered good enough for all practical purposes.

(v) They suggest that definite standards should be laid down in respect of the variations from the standard values which occur due to the temporary high temperature conditions.

It is not deemed necessary to go into these details and incorporate them in a Design Code.

3. *Madhya Bharat State Government Electricity Department.*	
(i) They agree with the standardization proposals.	
(ii) As per the chart in Exhibit II Indore falls in the temperature range of 100°F (140-40). They agree with the upper limit but they say that the minimum temperature in winter in Indore goes as low as 32° to 35°F.	Same remarks as in the explanatory note against item 2(iv).
4. *Madhya Pradesh State Government Electricity Department.*	
(i) They agree to the standardization proposed.	
(ii) They agree to the wind pressures indicated but they are of opinion that the temperature range of 100°F is not adequate especially for the eastern part of their State as they are afraid that, in view of the proposed lower clearances in the Draft I.E. Rules, variations beyond 100°F might lessen the clearance still further.	Same remarks as in the explanatory note against item 2(iv).
5. *Chief Electrical Engineer to the Government of Saurashtra.*	
(i) As per the Indian Meteorological Department's chart, Saurashtra comes in the 40 lb./sq. ft. wind pressure area corresponding to nearly 97 miles, hr. wind velocity, which they consider very high. They are designing for 25 lb./sq. ft. in coastal area and 20 lb./sq. ft. normally in inland area. They have extensive overhead lines in coastal areas based on 25 lb./sq. ft. but no special difficulty is experienced till now	It has been ascertained from the Indian Meteorological Department (see Annexure I) that although a wind pressure of 40 lb. per sq. ft. is the probable highest maximum to be expected, a safe and economical basis for design would be 20 lb. per sq. ft. except in the coastal reaches, as the probability of higher wind pressures in the inland areas is very remote and even if such higher values occur rarely, the factor of safety assumed in the designs can take care of the increased loadings. A peculiar feature of these storms is that they usually weaken rapidly after crossing the coast and the interior of the country does not experience the full intensity of the severe winds (see Annexure II). As a measure of precaution, therefore, the lines situated within 10 miles of the Saurashtra coast may be designed on the basis of 30 lb./sq. ft. which itself corresponds to a wind velocity of 100 miles per hour. The introduction of an extra wind pressure area of 25 lb. (in addition to 10, 15, 20 and 30) is not considered to be quite desirable in the interest of standardization.

6. *Electric Grid Office, Government of Bombay.*

(i) They are in favour of standardization.

(ii) They agree to the proposal of using 10 lb./sq. ft. wind pressure for rural lines up to 11 kV in the 15 lb. region shown in blue colour in Exhibit I.

(iii) They are of opinion that the usual practice of assuming higher values of wind pressure for towers than for conductors, has no logical basis in the face of experimental data, and agree that the same wind pressures may be assumed for conductors as well as towers.

(iv) They agree that 1.5 times the wind load on one face should suffice for all types of towers for average conditions, although according to them, the results of the experiments carried out by the ERA in England would seem to indicate that the total wind load is about 1.5 times the load on the wind-ward face in the case of square base tower and about 1.8 times (or so) depending upon the ratio of breadth to width of sides in the case of rectangular towers with longer sides at right angles to the direction of the line (which is usual).

(v) They are of opinion that in assessing the wind pressure on conductors a distinction should be made between solid and stranded conductors for the following reasons :—

(a) Wind load on the conductors constitutes a major portion of the load on the normal structures, and hence any variation in it will affect the design of structures considerably.

(b) The distinction between solid and stranded conductors may not be considered necessary where the wind pressure is supposed to act on the conductors covered with ice. But in India there is generally no ice covering to be accounted for and therefore the increase of this factor from 0.66 to 0.89 or 0.93 assumes greater importance.

While it is true that the theoretical multiplication factor varies with the type of conductor, solid or stranded, and with the number of strands in the case of stranded conductors, the general design practice followed in India and other countries as well, is to use a single factor for both solid and stranded conductors, even in cases when ice loading is not involved. In view of the several uncertainties involved in the computation of wind pressures, etc., it is therefore advisble to adopt the 2/3 factor for all solid and stranded conductors alike.

(vi) They agree with the proposals in respect of temperature variations.

7. *Hyderabad State Government Electricity Department.*

No comments.

8. *Orissa State Government Electricity Department.*

(i) They are in favour of standardization.

(ii) A wind loading of 40 lb. per sq. ft. may be adopted for conductors and towers in the cyclonic areas near the coast of Orissa, North Madras and Bengal. They further suggest that beyond this region although the pressure is given in the Map as 20 lb. and 15 lb., it would be advisable to adopt 25 lb./sq. ft. both for conductors and towers.

It has been ascertained from the Indian Meteorological Department that the provision of 30 lb. per sq. ft. along the North Madras, Orissa and Bengal coasts above 16° North Latitude is sufficient (See Annexure II). Accordingly the 40 lb. belt on the east coast (as per the IMD Map) has been downgraded to 30 lb. per sq. ft. as shown in Exhibit I. The adoption of 25 lb. per sq. ft. in place of 20 lb. and 15 lb. pressure in regions other than the cyclonic areas near the coast will unnecessarily boost up line costs and is not considered desirable in view of the fact that the areas corresponding to these pressures indicate regions in which the pressure is not likely to exceed the value shown for each hatching, and that the factors of safety assumed in the designs will ordinarily take care of any excess loading over and above the pressures indicated in these two regions, which may occur for short periods and at long intervals of several years.

(iii) In places like Cuttack where the temperature goes up to 120°F (?) a temperature range of 120°F (160°—40°) for conductors will be ample and in places where the lines run at higher altitudes than 2000 ft. a temperature range of 118°F (150°—32°) may be adopted.

Same remarks as in the explanatory note against item 2(iv).

(iv) They propose to specify for their lines a factor of safety of 2.25 for conductors with wind pressure of 25 lb. (except in cyclonic area where 40 lb. pressure will be allowed for) with a range of 118°F in areas above 2000 ft. and 120°F in the coastal areas. They add that a higher maximum temperature is allowed for than mentioned in the proposals by about 10°F in order that the clearance above ground may not go below 20′ even when there is a slight error in stringing tension.

The question of standardizing the factors of safety of conductors will be dealt with in a separate code or Practice.

9. *Electricity Development, Government of West Bengal.*

(i) They are in favour of standardization

(ii) According to them, an examination of the wind velocities recorded at the Alipore Observatory over a period of 10 years shows the following :—

(a) The maximum wind velocities were recorded in the summer months each year ;

Same remarks as in the explanatory note against item 2(iv).

(b) on only three days the maximum velocities exceeded 70 mph and that only for a few minutes, the normal velocities seldom exceeding 30 mph ; and

These figures, if applied for the whole of Bengal, would be on the conservative side. According to the Indian Meteorological Department (See Annexure II), there have been occasions in the past when winds over 100 mph have actually been recorded in the Bengal coastal region, but the provision for 30 lb. pressure (corresponding to wind velocities of 100 mph) would however be sufficient. For the rest of Bengal, the Map specifies 20 lb. pressure.

(c) during the low temperature period the wind velocity is relatively low.

(iii) They agree that the same wind pressure may be assumed for towers as for conductors.

(iv) They agree to the same 2/3 factor being applied for solid as well as stranded conductors in assessing the wind pressure on wires.

(v) They state that the meteorological records of the Alipore Observatory indicate that the normal range of shade temperature variation is 47°—109°F, no temperature higher than 109°F having been recorded during a period of 10 years and that the corresponding sun temperatures are 47+55= 102°F in January and 109+71=180°F in June.

An increase of 55°F and 71°F to the minimum temperature and maximum temperature respectively is not quite in order. At minimum temperatures the sun's radiation does not exist and at maximum temperatures it would be a reasonable assumption to add 30°F to allow for the sun's radiation, heating effect of current, etc. Even if the actual maximum temperature is a little more than what is recommended in the Code, this will not be of any serious consequence, as explained in the explanatory note against item 2(iv).

(vi) The worst wind loading condition does not occur at the time of minimum temperature when wind velocity is not maximum.

As regards the maximum working tension of the conductor, the condition of minimum temperature and maximum wind is the worst that can possibly occur ; designs should therefore be based accordingly. Reliable data are not available for all places in this country about the actual combination of wind pressure and temperature to produce the worst loading conditions. This Commission is under correspondence with the Indian Meteorological Department on this subject.

10. *Bihar State Government Electricity Department.*

(i) The wind pressure of 15 lb./sq. ft. on 2/3 the projected area of conductor for designing transmission and distribution lines has been found to be quite satisfactory.

(ii) No other Comments.

11. *Electrical Adviser (Development), Assam.*

The wind pressure has always been reckoned by them as 15 lb. per sq. ft. and the average temperature as 80°F.

According to the Wind Pressure Map (Exhibit I), most areas of Assam are subjected to a maximum pressure of 20 lb. per sq. ft. and it is preferable to adopt this value on all future designs. The temperature variation of 80°F accords with the recommendations contained in the Code.

12. *Delhi State Electricity Board.*

No Comments.

13. *Calcutta Electric Supply Corporation Ltd.*

(i) They agree that the wind pressure for which conductors and towers are to be designed should be the same.

(ii) They are of the opinion that the figures of temperature variation recommended for Bengal are somewhat low and that the maximum and minimum temperatures should be approximately 150°F and 45°F respectively.

The recommended figures of temperature variation are a 140°—40°F for most areas of West Bengal and 130°—50°F for the coastal areas around Calcutta. Slight variations upto 10° or 20°F are immaterial, as explained in the note against item 2(iv).

14. *The Ahmedabad Electricity Co. Ltd.*

(i) They suggest that a wind pressure of 15 lb./sq. ft. can be adopted throughout the country.

If a wind pressure of 15 lb. were to be assumed for a 30 lb. area, there would hardly be any margin of safety if the lines were subjected to double the design loadings. These recommendations are not therefore acceptable.

(ii) A temperature variation of 100°F, they suggest, may be adopted for the whole of India.

For a subcontinent like India covering the latitudes from 8° to 36°, it could hardly be appropriate to fix up a uniform value of 100°F for temperature variation. Three zones as recommended in the Code constitute a reasonable compromise with the actuals.

(iii) They agree with other proposals.

15. *Electricity Supply Companies (Martin Burn Ltd.).*

In their opinion it appears to be impossible if maximum economy is to be affected, to evolve uniform standards for the whole of India.

This argument is not helpful and can always be advanced against any proposal for standardization.

16. *Sijua (Jherriah) Electricity Supply Co. Ltd.*

They are in agreement with the proposals and confirm that the temperature difference as shown in the map closely agrees with the conditions in the Jharia Coal-field.

17. *The Poona Electric Supply Co. Ltd.*

(i) They are in general agreement with the proposals.

(ii) They have been adopting a wind pressure of 15 lb./sq. ft. in all their designs and it has been found satisfactory.

Poona falls in the border line between 15 and 20 lb. zones. In such cases, it may be left to the authorities concerned to base their designs on the lower or higher values depending on the importance of the line or scheme involved.

18. *The Tata Hydro-Electric Agencies.*

(i) They agree that the same wind pressures should be adopted for towers as for conductors. Their towers are designed for the simultaneous loading of only 15 lb./sq. ft. wind pressure on towers and conductors and one broken wire condition in the case of s/c. line and 2 broken wire condition for d/c. lines with a minimum f. s. of 2.5 for steel.

Depending on whether the lines are situated in the 20 or 15 lb. areas as per the Map, it is preferable to design the lines accordingly. The Tatas adopt some margins in computing the tower loadings. The acceptance of the recommendations in the Code will not ultimately involve extra costs.

(ii) They agree that for compound structures 1½ times the wind pressure on the windward side may be taken and that the 2/3 factor can be uniformly applied for all solid and stranded structures.

(iii) They generally agree with the temperature variation figures.

19. *The South Madras Electric Supply Corporation Ltd.*

(i) Their H.T. & L.T. lines are based on a wind pressure of 10 lb. per sq. ft. and damages due to gales have so far been very few. They strongly recommend the retention of 10 lb. pressure for their areas with a view to keeping down rural line costs.

This suggestion to retain the wind pressure as 10 lb. per sq. ft. has been incorporated in the recommendations for rural lines only (up to 11 kV). This applies only to the 15 lb. region shown in the blue colour in Exhibit I.

(ii) Their lines are based on a temperature difference of 40°—140°F and they prefer retention of these values.

80°F variation as per Exhibit II is quite safe as explained in the note against item 2(iv).

20. *W T. Henleys Telegraph Works Co. Ltd.*

(i) They consider that the 10 lb./sq. ft. area should be upgraded and merged with the 15 lb./sq. ft. area.

(ii) They agree that the wind pressure should be the same for towers as for conductors.

(iii) They are of the opinion that no modification need be made to paras. (b) and (c) of Rule 68(2) of the Indian Electricity Rules.

21. *British Insulated Callender's Cables Ltd.*

They are in general agreement with the views expressed in the circular but they feel that as contractors they are not in a position to make recommendations because they do not have operational experience of transmission lines in India.

22. *Posts & Telegraphs Department (Development).*

Their comments are more with reference to the design requirements of communication lines while the circular letter relates to power supply circuits.

L481CWPC(P.W.)—300—24-10-52—GIPS

EXHIBIT – II

MAP OF INDIA

SHOWING TEMPERATURE VARIATIONS

(FOR OVERHEAD LINE DESIGNS)

SCALE :- 1:10,000,000 AT LAT 22°-30'.

MERCATOR PROJECTION

(OR 157·83 MILES TO AN INCH)

80°F (130°-50°)

100°F (140°-40°)

120°F (150°-30°)

NOTE :-

(1) THIS MAP IS BASED ON THE ABSOLUTE MAXIMUM AND MINIMUM TEMPERATURE OBSERVATIONS AS RECORDED BY THE I.M.D. UP TO 1940. 30°F HAS BEEN ADDED TO THE MAXIMUM TEMPERATURE VALUES TO ALLOW FOR THE SUN'S RADIATION, HEATING EFFECT OF CURRENT ETC.

(2) THIS CHART DOES NOT HOLD GOOD FOR AREAS AT ALTITUDES GREATER THAN 3000 FEET.

The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative. Sikkim and Bhutan are attached to India by special treaty.

SSM/VV

STATUTE MILES.

CENTRAL WATER & POWER COMMISSION, SIMLA

E. of GREENWICH.

Reg. No. 3034 H E'52-300.

Reproduced from the original map.

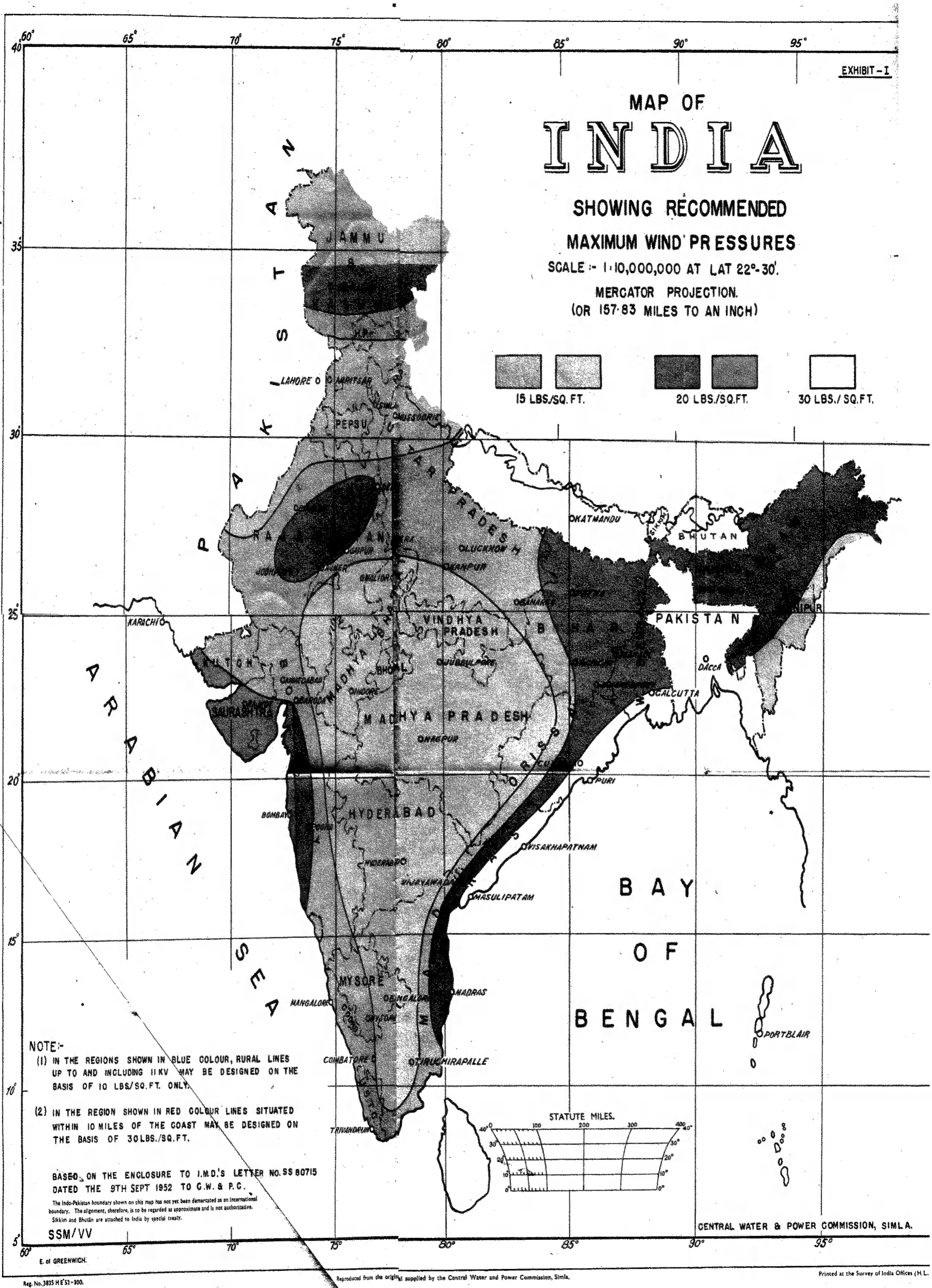
EXHIBIT - I
MAP OF
INDIA
SHOWING RECOMMENDED
MAXIMUM WIND PRESSURES
SCALE :- 1:10,000,000 AT LAT 22°-30'.
MERCATOR PROJECTION.
(OR 157·83 MILES TO AN INCH)
15 LBS./SQ. FT.
20 LBS./SQ.FT.
30 LBS./ SQ.F.T.
PAKISTAN
ARABIAN SEA
BAY OF BENGAL
PAKISTAN
BHUTAN
VINDHYA PRADESH
MADHYA PRADESH
HYDERABAD
MYSORE
PEPSU
SAURASHTRA
KARACHI
LAHORE
CALCUTTA
DACCA
PURI
VISAKHAPATNAM
MASULIPATAM
MADRAS
TIRUCHIRAPALLE
TRIVANDRUM
COIMBATORE
MANGALORE
BOMBAY
PORTBLAIR
KATMANDU
LUCKNOW
STATUTE MILES.
NOTE:-
(1) IN THE REGIONS SHOWN IN BLUE COLOUR, RURAL LINES UP TO AND INCLUDING 11 KV MAY BE DESIGNED ON THE BASIS OF 10 LBS/SQ.FT. ONLY.
(2) IN THE REGION SHOWN IN RED COLOUR LINES SITUATED WITHIN 10 MILES OF THE COAST MAY BE DESIGNED ON THE BASIS OF 30 LBS./SQ.FT.
BASED ON THE ENCLOSURE TO I.M.D.'S LETTER NO. SS 80715 DATED THE 9TH SEPT 1952 TO C.W. & P.C.
The Indo-Pakistan boundary shown on this map has not yet been demarcated as an International boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative. Sikkim and Bhutan are attached to India by special treaty.
SSM/VV
CENTRAL WATER & POWER COMMISSION, SIMLA.
E. of GREENWICH.

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